



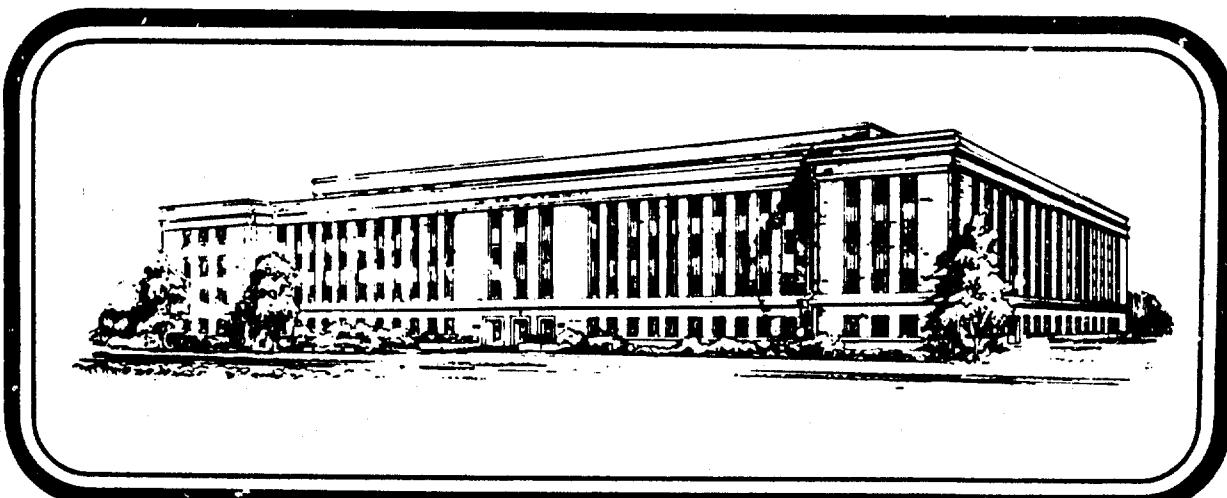
NATIONAL DEFENSE UNIVERSITY

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**MOBILIZATION AND DEFENSE MANAGEMENT  
TECHNICAL REPORTS SERIES**

AD A138179

**THE ATTACK HELICOPTER FOR THE MARINE CORPS  
IN 1985, AH-64 APACHE OR AH-1T SEA COBRA**



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THE INDUSTRIAL COLLEGE OF THE ARMED FORCES  
NATIONAL DEFENSE UNIVERSITY

INDIVIDUAL RESEARCH PROGRAM

THE ATTACK HELICOPTER FOR THE MARINE CORPS IN 1985:  
AH-64 APACHE OR AH-1T COBRA

BY

CURTIS T. CRENS, LTCOL, USMC

A RESEARCH REPORT SUBMITTED TO THE FACULTY  
IN  
FULFILLMENT OF THE RESEARCH  
REQUIREMENT



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THE INDUSTRIAL COLLEGE OF THE ARMED FORCES

APRIL 1983

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**ABSTRACT OF STUDENT RESEARCH REPORT  
INDUSTRIAL COLLEGE OF THE ARMED FORCES**

NAME OF RESEARCHER (S)	TITLE OF REPORT
Crews, Curtis T.	The Attack Helicopter for the Marine Corps in 1985: AH-64 APACHE or AH-1T COBRA
SECURITY CLASSIFICATION OF REPORT	REPORT NUMBER
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**ABSTRACT**

Problem Statement: In FY85 and 86, the Marine Corps intends to procure additional attack helicopters. The purpose of this Research Project is to evaluate the available options, the AH-64 APACHE and the AH-1T SEA COBRA, from three directions: first, from the mission analysis aspect; secondly, the ability of the available options to counter the threat; and third, from a cost analysis basis. The latter aspect is envisioned as the most significant due to the large increase in procurement costs during the last decade for both fixed wing and helicopter aircraft. The AH-1T COBRA was developed by the Marine Corps and manufactured by Bell Helicopter Textron, Inc., Ft. Worth, Texas. The AH-64 was developed by the Army and manufactured by Hughes Helicopters, Inc., Los Angeles, California.

Finding/Conclusions:

1. Both attack helicopters possess the basic capability to complete the assigned mission.
2. The APACHE is not shipboard compatible.
3. The APACHE lacks the air-to-air capability of the COBRA.
4. The COBRA is not as survivable as the APACHE.
5. The COBRA lacks adequate fire control for its weapon systems.
6. The APACHE is approximately twice the cost of the COBRA. ←

Recommendations:

1. Procure AH-1T COBRAs in FY85/86.
2. Further evaluate the AH-64 APACHE for changes required for shipboard compatibility and possible future procurement.

**THIS ABSTRACT IS UNCLASSIFIED**

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EXECUTIVE SUMMARY

Purpose: To evaluate the two available options for a planned and budgeted procurement of attack helicopters by the U.S. Marine Corps in Fiscal Years 85 and 86; and to make a recommendation as to which option should be pursued. The study is intended to present an evaluation from a "user" viewpoint. The results of this study, along with other currently ongoing studies will facilitate the decision making process.

Problem: Funds have been appropriated in the 1985/86 Program Objective Memorandums to purchase additional attack helicopters for the U.S. Marine Corps. The two available purchase options are the AH-1T COBRA manufactured by Bell Helicopter Textron, and the AH-64 APACHE manufactured by Hughes Aircraft.

Data: The data used in this analysis was collected from current service publications, factory design data, flight test results, and interviews with persons of demonstrated knowledge and ability in the attack helicopter community.

Results: Analysis of data collected indicate that there is no clear cut choice between the two options. Each option has certain advantages and disadvantages when viewed against each other. There is, however, a choice which will meet the demands outlined and which can be procured to meet Marine Corps replacement and projected attrition through the 1980's. This option also has a significant advantage in terms of shipboard compatibility, cost, and air-to-air capability.

Conclusions and Recommendations: The AH-1T COBRA is the most viable procurement of the two options. It is recommended that the U.S. Marine Corps contract with Bell Helicopter Textron, Inc. for as many additional AH-1T COBRA attack helicopters as available funding will allow. It is also recommended that the Marine Corps commence an indepth evaluation of requirements to make the APACHE shipboard compatible and determine the exact costs, both recurring and non-recurring, with a view toward possible future procurement.

AUTHOR

The attack helicopter is a subject which LTCOL Crews has been involved with for the last 12 years. During that time he has accumulated over 1500 flight hours in attack helicopters. In 1969 LTCOL Crews attended the U.S. Army Cobra Gunship training school at Savannah, Ga. and subsequently served a tour in Vietnam flying the AH-1G COBRA. In 1973, he attended the U.S. Navy Test Pilot School and was assigned as an attack helicopter engineering test pilot. As a test pilot he conducted flight tests for the Iranian AH-1J and USMC AH-1T procurements. These tests consisted of over 100 anti-armor missile firings and 500 flight hours of flying qualities and performance flights. LT COL Crews was then assigned as the operations officer of Marine Attack Helicopter Squadron 269 and in this capacity he instructed and qualified the first Marine aviators in the AH-1T. In 1979, he was reassigned as the executive officer of the first Marine squadron to deploy the AH-1T aboard amphibious ships operating in the Mediterranean Sea. In 1980 LT COL Crews became Deputy Program Manager for Attack Helicopters at Naval Air Systems Command, Washington, D.C. LTCOL Crews' duties have included, engineering test pilot, flight instructor, flight leader, mission commander, forward air controller, and advisor to the Iranian government concerning employment of their attack helicopters.

SECTION I

INTRODUCTION

Picture yourself in a tank, infantry fighting vehicle or on the ground in a foxhole. As a member of an armored or infantry unit, you are listening to the awesome sound of enemy armor to your front. A sound that plays tricks with the imagination due to its magnitude and the fact it is dark and raining making it nearly impossible to see.

Unknown to you the call has gone out to the attack helicopters which have navigated from their holding position to an area near you from which they can engage the enemy. Suddenly, the air is filled with rockets, 25mm, and TOW or HELLFIRE missiles. To your front, the battlefield is aglow with the explosions of enemy tanks and personnel carriers. Soon the enemy advance has stopped and the tide of battle is turned.<sup>1</sup>

On today's integrated battlefield and the battlefield of tomorrow, the attack helicopter is an invaluable "force multiplier" that provides an added lethal dimension to the U.S. Marine Corps (USMC) air/ground team. A unique and essential fire support system, the attack helicopter provides an immediate response to the needs of the ground commander in day/night or adverse weather conditions. It can perform close-in fire support with pinpoint accuracy and defeat the enemy with an array of weaponry never before imagined.

Since the latter part of the Vietnam war, attack helicopters have become an integral and significant element of the USMC air/ground team. With the introduction of the AH-1G COBRA gunship in 1969, in the role of armed escort

for the transport helicopters, the combat loss rate for transport helicopters decreased by greater than 30%.<sup>2</sup> This experience proved the capability of a helicopter dedicated to the attack mission and resulted in the continued expansion of the attack helicopter community in both the Marine Corps and the Army.

The growth of the attack helicopter has not followed the traditional rules of aircraft development and acquisition, but evolved through requirements dictated by the Vietnam conflict. Thirty-eight single-engine COBRAS were procured from the U.S. Army as an interim attack helicopter to offset Vietnam attritions of the HUEY helicopters which were light transport helicopters hastily converted to the gunship role. At the same time, the USMC commenced a development program for a shipboard compatible, twin-engine attack helicopter. This development program resulted in the procurement of forty-nine AH-1J COBRAS. The AH-1J COBRA incorporated twin-engines, an improved fire control system and a 20mm cannon mounted in a nose turret.<sup>3</sup>

The AH-1J COBRA proved to be a reliable and much sought after aircraft. Because of its improved and expanded capabilities, ground commanders demanded more use and greater numbers of COBRAS, which conflicted with its primary role of transport helicopter escort. In 1973, additional mission requirements were identified including increased payload and an anti-armor capability. In 1974, funds to accomplish the desired improvements were provided and the improved model was designated to AH-1T COBRA. The latter COBRA variant, last delivered in October 1979, has proven extremely reliable and is in constant demand, deployed simultaneously to as many as 50 independent operating sites in the

U.S. and abroad.<sup>3</sup> With its added anti-armor capability, the COBRA has been targeted for new growth with additional airframes to fulfill force level requirements and to replace attrited attack helicopters.

While the USMC was developing its attack helicopter, the U.S. Army was developing an attack helicopter of its own. The biggest difference between these two programs was the requirement for Navy shipboard compatibility and transport escort mission versus the Army's exclusive anti-armor requirement. The resulting Army AH-64 APACHE attack helicopter is a dual-engine aircraft that many believe could fulfill the USMC mission, including the escort task and be shipboard compatible with minimal changes.

With increased demand by ground commanders for attack helicopters to counter the enemy armor threat, for day/night and inclement weather compatibility, and for replacement of attrition aircraft, it is essential that a new attack helicopter be procured. Funding in the 1985 Five Year Defense Plan (FYDP) will allow this procurement. The question is what to buy - an improved AH-1T COBRA or an AH-64 APACHE?

#### OBJECTIVE

The objective of this research project is to examine the two procurement alternatives and make a recommendation as to which helicopter to purchase. The first alternative is the AH-1T COBRA manufactured by Bell Helicopter Textron, Inc. The Marine Corps presently has three squadrons of COBRAS totaling 107 airframes.<sup>4</sup> The second alternative, the AH-64 APACHE manufactured by Hughes Helicopter, has been approved for production with deliveries to begin in 1984.<sup>5</sup>

Each of the alternatives will be examined in the following areas:

1. Characteristics and Capabilities.
  - a. Physical/Flight
  - b. Weaponry
  - c. Shipboard Compatibility
2. Ability to meet all tasks assigned to attack helicopters by Marine Corps doctrine.
3. Ability to counter the threat.
  - a. Air-to-Ground
  - b. Air-to-Air
4. Cost.
  - a. Investment Cost
  - b. Shipboard Compatibility

ASSUMPTIONS

This research project is based on the following assumptions:

- A. That the FYDP and the FY85 and FY86 Program Objective Memorandums will continue to include funding for additional attack helicopters.
- B. That procurement will be authorized in FY85 and FY86.
- C. That short lead times for this procurement eliminate consideration of options that have not completed development and are entering production, or are not included in production plans.
- D. That mission assignments will remain unchanged over the next 10 to 15 years.

#### LIMITATIONS

This research project is limited due to the fact that the current Marine Corps' position is that the APACHE and COBRA are not competitors and therefore are not comparable entities.<sup>6</sup> It is reasoned that the helicopters were developed for two different missions and to compare them is mixing oranges and apples. Therefore, very little comparison data are available. With this in mind, the author believes that with the advent of increased cost of aircraft in the last decade and the greater demand for state-of-the-art weapons, an effort must be made to perform a mission capability comparison between these two aircraft. Even without substantial qualitative data, this study will have an equal portion of objective and subjective substance to assist the decision maker in choosing the most viable procurement alternative.

SECTION II  
THE ALTERNATIVES FOR FY85/86

This chapter commences the capabilities comparison of the two attack helicopter options. Both the AH-1T COBRA and the AH-64 APACHE attack helicopters offer the Marine Corps attractive capabilities. The question is, which is best suited for Marine Corps doctrine and which can accomplish the mission within current procurement funding levels.

Table 1 depicts the general characteristics of the two aircraft which readily lend themselves to the comparison process. Figures 1 through 4 of Appendix B provide visual comparisons and principle dimensions of the aircraft.

TABLE 1

<u>AIRCRAFT CHARACTERISTICS</u>		
	<u>COBRA</u> <sup>7</sup>	<u>APACHE</u> <sup>8</sup>
Maximum Straight and Level Airspeed	160 kts	167 kts
Maximum Payload (Ordnance)	3300 lbs	5045 lbs
Endurance	2.5 hrs	1.8 hrs
Turret Cannon	20mm	30mm
Round Capability	750	1200
Rate of Fire (Cannon)	675 rmp	800 rmp
Missile System	TOW/HELLFIRE/SIDEWINDER	
Maximum Range	310 nm	330 nm
Length	58 ft	58 ft 3 in
Width	10 ft 8 in	17 ft 2 in
Height	13 ft 8 in	16 ft 8 in

The COBRA presently in the USMC inventory, is a tandem, two-place, twin-engine, single-rotor, two-bladed attack helicopter. It is designed and built around the fighting mission. It is highly maneuverable and capable of self-defense in hostile battle situations.

AH-1T COBRA

The proposed AH-1T COBRA for the FY85/86 procurement has been significantly improved over the aircraft in the existing inventory. Improvements include increased engine performance, modernized cockpit, new missile systems and Aircraft Survivability Equipment (ASE).

A. Increased Engine Performance. The presently installed engine, with 1970 shaft horsepower, will be replaced with a 3250 shaft horsepower engine. The new engine improves the high altitude, hot day performance of the COBRA and adds 3 kts to the straight and level airspeed capability.<sup>9</sup>

B. Modernized Cockpit. The cockpit will incorporate a modernized multiplex design to ease maintenance, enhance survivability, and allow a reduced pilot work load, particularly at night. Wire bundles have been reduced, sophisticated fault detection systems added, and displays simplified to eliminate some instruments and switches.

C. Hellfire Missile. The addition of this system is a decided plus. The Hellfire is a "fire and forget" missile as opposed to the TOW missile which must be optically tracked and guided in vulnerable flight parameters. The Hellfire increases stand-off capability and probability of kill.

D. Sidewinder Missile System. The Sidewinder AIM-9L is a supersonic air launched guided missile which can be launched from the head-on attack as well as from the tail-on position. This feature greatly reduces engagement time and maximizes the launch and leave feature in the air-to-air multi-target environment. The AIM-9L has a tighter turn capability and a more sensitive Infra-Red (IR) sensor than earlier missile systems. The missile can be used with any aircraft optical system, avionics, radar and helmet mounted sights. It is the primary short-range air-to-air missile for U.S. Navy and Air Force first line fighter aircraft.<sup>10</sup>

E. ASE. The ASE equipment includes various small airframe modernizations which, when taken together, are a significant improvement in overall aircraft survivability. These include:

1. Active and Passive Radar Warning.
2. Infra-Red Jamming.
3. Low Infra-Red Reflective Paint.
4. Chaff and Flare Dispensing Systems.
5. Composite Rotor Blades, to provide high ballistic tolerance.

The COBRA has a very narrow silhouette which makes it difficult to acquire. Its impressive dash speed and 160 kts straight and level airspeed, allows it to escort transport helicopters along routes of assault and then dash ahead at the last minute to deliver Landing Zone (LZ) suppressive fires and lay down smoke screens. Its close-in fire support capabilities rival those of any other aircraft in terms of accurate fire delivered at minimum distance from friendly troops. Its tremendous maneuverability, tight turn

radius, and near acrobatic flight parameters render it particularly effective in air-to-air encounters and maneuvering in and around LZs. Additionally, its two anti-armor missile systems (TOW/HELLFIRE) allow a deadly punch with a high probability of kill.

The COBRA has 2.5 hours of endurance and can carry a payload of 3300 pounds. This payload may consist of a mix of the following weapons:<sup>11</sup>

**A. Guided Missiles**

1. Eight TOW (Anti-Armor)
2. Eight Hellfire (Anti-Armor)
3. Four Sidewinder (Air-To-Air)

**B. Fire Support Weapons**

1. 750 Round 20mm Cannon Turret
2. 76 2.75 inch Folding Fin Aerial Rockets (FFAR)
3. Four MK-81/82 Bombs
4. Two MK Five Bombs
5. Four MK-76/106 Bombs
6. Two GPU-2/A 20mm Gun Pods
7. Sixteen 5 inch Zuni Rockets

**C. Special Mission Stores**

1. SUU-44 Flare Dispensers
2. M-118 Smoke Grenade Dispenser
3. ALE-39 Chaff Dispenser
4. Two 100 Gallon Auxiliary Fuel Tanks

AH-64 APACHE

The APACHE is a two-place, twin-engine, rotary-wing aircraft specially designed to deliver anti-armor and area fire suppression in day, night and adverse weather conditions. Design emphasis, in addition to the all-weather and day/night capability, was placed on the ability to fight, survive, and live with the troops in the front line battlefield environment.<sup>12</sup>

The APACHE employs a four-bladed rotor system and a wheeled, three-point landing gear system. The pilot flies in the rear cockpit. It incorporates a target acquisition/designation system; a pilot's night vision sensor; and an improved, integrated fire control system.

The APACHE program placed a great deal of emphasis on survivability. The end result was a major improvement in detectability and hardening.

A. Detectability. In addition to its maneuverability and night and all weather capability, the aircraft has a low flicker rotor system which is 50% quieter than most other rotor systems. It has a low glint canopy to reduce visual detection and uses composite materials and special engineering to reduce radar signatures. Its engine plume suppressors reduce IR signatures.<sup>13</sup> All these features significantly reduce detectability.

B. Hardening. The APACHE has redundant flight controls, self-sealing fuel cells, and armor plating of crucial components. It incorporates 23mm blast shields for the crew and uses special alloy airframe materials which make it practically invulnerable to enemy fire of 12.7 caliber or smaller and has a low vulnerability to 23mm fire.<sup>14</sup>

Other special features of the APACHE include an 800+ mile ferry capability which permits trans-atlantic ocean flight capability, a 30mm cannon with 1200 round capacity, and a Hellfire missile system providing up to 16 missiles per launch.<sup>15</sup> The APACHE can also carry 2.75 inch aerial rockets, as alternate stores with Hellfire missiles. Another significant claim of the contractor is the Reliability, Availability and Maintainability concept which is supposed to have achieved significant improvements in case of maintenance. This claim is yet to be fully documented in other than operational tests and evaluations conducted prior to the production decision.

To further explore and compare the capabilities of the COBRA and APACHE it is necessary to examine in detail their ability to meet the elements of the attack helicopter mission.

### SECTION III

#### THE ASSIGNED TASKS

##### INTRODUCTION

All attack helicopters procured by the Marine Corps are assigned to Marine Attack Helicopter Squadrons. The squadron mission is:

". . . to provide close-in fire support and fire support coordination in aerial and ground escort operations during the ship-to-shore movement and within an objective area."<sup>16</sup>

In order to accomplish this mission, specific tasks are performed by attack helicopters and their crews. Accordingly, the paramount concern is that any attack helicopter procured for the Marine Corps be inherently capable of successfully performing these tasks.

##### THE TASKS

The tasks which Marine attack helicopters must be able to perform are:

1. Conduct armed escort flights in support of personnel and cargo carrying helicopters.
2. Provide landing zone suppression fire support.
3. Conduct visual and armed reconnaissance.
4. Provide target marking and airborne direction for the attack of surface targets by high performance aircraft.
5. Escort and provide suppressive fires for surface convoys and other ground unit operations.

6. Maintain the capability to operate from LPHs, LPDs, or other floating bases.
7. Conduct point target attack of threatening armor.
8. Provide air coordination for the utilization of supporting arms.
9. Maintain the capability to operate under conditions of darkness and reduced visibility.<sup>17</sup>

Both helicopters being considered are judged by their ability to meet the assigned tasks as follows:

Task 1. Armed Escort. Each is capable for performing the armed escort task. The APACHE enjoys a 6 to 9 kts speed advantage over the COBRA and thus has a slight edge in the escort role. The COBRA has a .7 hour endurance advantage over the APACHE, which is significant since after the initial assault wave has landed, quick force buildup is required; with greater endurance more sorties can be accomplished prior to refueling.

Task 2. LZ Suppression. Both aircraft can handle this task superbly. However, the 1200 round capacity of the APACHE and its fire control system, allows first round hit capability, and gives it an advantage over the COBRA which does not have a fire control system.

Task 3. Visual/Armed Reconnaissance. Both aircraft have excellent Field of View (FOV) from the cockpits. However, from personal experience in both cockpits, the COBRA has a slightly better FOV. This advantage is due to smaller canopy supports and struts and lower instrument panels.

Task 4. Forward Air Control Airborne (FACA). Both aircraft can perform this task well. Rocket capability and smoke grenade racks offer a good marking capability and the UHF/FM radios afford communications with both air and ground units. The APACHE, unlike the COBRA, possesses a VHF radio capability which is of special importance as most allied NATO aircraft have VHF radios vice UHF. On the other hand, the COBRA has greater loiter time than the APACHE, a significant advantage for FACA missions which usually require extensive time on station. If FACA changes are frequent due to short loiter times airborne mission turnover briefs are required which can lead to confusion and lost target engagement time. Accordingly, a FACA aircraft with longer endurance is a definite advantage.

Task 5. Ground Unit Escort. Both helicopters can readily accomplish this task. The COBRA's greater endurance is an advantage. However, when it comes to delivering accurate, close-in fire support to friendly troops, the APACHE fire control systems with its first round hit capability has a significant advantage.

Task 6. Amphibious Capability. This task is the most significant factor in determining overall mission capability of the two aircraft, within the parameters of the unique Marine Corps mission. The requirement to operate from naval shipping has dealt hard blows to many aircraft due to the severe salt water environment, special handling and securing requirements, and safety requirements of Hazard of Electromagnetic Radiation to Ordnance (HERO). These factors are of such importance that the Naval Air Systems Command conducted a "hands-on" look at an APACHE development model in September 1982. This

evaluation focused on tests to determine those modifications necessary for shipboard compatibility. The test results are contained in Appendix C. The general conclusion of the test was that the APACHE can be adapted for shipboard operations. However, a more important issue is one of cost for such modifications. It is modification costs that will ultimately determine amphibious capability.

The COBRA has been successfully operating aboard Naval shipping since June 1981. The major shortcoming of the COBRA, however, is its rough IR paint which catches and holds salt crystals. This requires scrubbing the paint surfaces hard and frequently, causing fast deterioration of the paint's corrosion protection and IR suppression capability.

Task 7. Armor Destruction. This task is one of the newest for the Marine Attack Helicopter community. It is of particular significance due to the buildup of Warsaw Pact armor capability in the last decade. The COBRA can carry 8 anti-armor missiles, while the APACHE carries 16. The COBRA can also carry the older TOW missile in place of the Hellfire. The fact that the COBRA can utilize both missile systems is an enhancing characteristic.

The TOW missile is a continuous tracked weapon that requires the aircraft to remain in line-of-sight with the target. Its maximum range is 3750 meters.<sup>18</sup> The TOW missile system has been in the arsenal since 1968 and has proved to be an accurate and dependable weapon. In a low intensity environment, the TOW is a very viable weapon but in the mid to high intensity battlefield it requires excessive exposure time for the aircraft to launch and subsequently track the missile to the target (20 seconds for 3000 meter shot).<sup>19</sup>

The Hellfire missile is laser-guided by an airborne or ground designator. It has three launch options, two direct-fire modes and one indirect-fire mode. The direct-fire modes use either an autonomous or remote laser designator. The autonomous designation involves illuminating the target with the launch helicopter's own laser from launch through impact. Remote designation requires only that the helicopter expose itself long enough for the missile to acquire the target and be fired. Indirect-fire uses remote designation and is designed to allow the launch helicopter to fire a missile while remaining in defilade (masked from the enemy by terrain).<sup>20</sup>

The APACHE can carry twice as many anti-armor weapons as the COBRA which is a distinct advantage in accomplishing the anti-armor task.

Task 8. Supporting Arms Coordination. Both helicopters possess a radio configuration sufficient to adequately accomplish this task. In terms of target spotting, the COBRA has a slight FOV advantage over the APACHE. However, the VHF radio capability of the APACHE is a plus when working with allied forces and aircraft.

Task 9. Night and Reduced Visibility Operations. Both aircraft possess a good night flying capability. However, the APACHE is superior due to its Pilot Night Vision Sensor System (PNVS) and Doppler navigation system. The PNVS allows the pilot to fly the helicopter at night using terrain following techniques. A real-time, passive "thermal image" of the "world" outside the cockpit is displayed on a helmet mounted display which the pilot views with one eye. The TV-like image is generated by a Forward Looking Infra-Red Radar (FLIR) sensor in the nose of the aircraft.<sup>21</sup>

SUMMARY

Both aircraft possess excellent capabilities to accomplish assigned mission tasks. Each one has some special characteristic that seems to counter its shortfalls, e.g., the APACHE can carry more anti-armor missiles, but lacks the endurance of the COBRA; the COBRA has slightly better FOV, but lacks the VHF radio communications of the APACHE. The most serious shortcoming of the APACHE at this point is its lack of shipboard compatibility. The Marine Corps is an amphibious force which must live on and operate from amphibious ships. This dictates that any aircraft employed by the Marine Corps must be fully shipboard compatible even at the degradation of mission accomplishment capability. To further bring the shipboard compatibility aspect into prospective, a cost analysis must be accomplished for the APACHE. This is discussed in an ensuing section.

SECTION IV

THE THREAT

General Creighton W. Abrams, former U.S. Army Chief of Staff, stated:

"The major military challenge to our global interests is the Soviet Union. It is the only other truly global military power, and so we must gage our ability to maintain freedom of action in terms of the Soviet Union, and in terms of the challenges that Soviet global interests and actions pose for us."<sup>22</sup>

The Soviet Armed Forces today number more than 4.8 million men.<sup>23</sup> For the past quarter century, we have witnessed the continuing growth of Soviet military power at a pace that shows little sign of slackening in the future. The facts of this buildup are stark:

A. Soviet Ground Forces have grown to more than 180 motorized rifle divisions, tank divisions and airborne divisions, all stationed in Eastern Europe, U.S.S.R., Mongolia, and Afghanistan. Soviet Ground Forces have achieved a capacity for extended intensive combat in the Central Region of Europe.

B. The Soviets have fielded 50,000 tanks and 20,000 artillery pieces. Soviet divisions are being equipped with the newer, faster, better armored T-64 and T-72 tanks with a new T-80 tank in development. Some artillery units, organic to each division, include new heavy mobile artillery, multiple rocket launchers and self-propelled, armored 122mm and 152mm guns.

C. More than 5,200 helicopters are available to the Soviet Armed Forces, including increasing numbers of MI-8 and MI-24 helicopter gunships used in direct support of ground forces on the battlefield.

D. More than 3,500 Soviet and Warsaw Pact tactical bombers and fighter aircraft are located in Eastern Europe alone. In each of the last eight years, the Soviets have produced more than 1,000 fighter aircraft.<sup>24</sup>

The Soviet air arm is highly sophisticated, consisting of fighter and attack aircraft, all of which pose a threat to the attack helicopter. These fixed wing aircraft carry a full range of weapons which can be employed effectively against heliborne forces. However, potentially the most dangerous threat is the Soviet attack helicopter. The presence of armed enemy helicopters on the battlefield presents a far more serious threat than the fixed wing attack and fighter aircraft. Weather often precludes the use of high performance aircraft; however, if weather permits us to employ our helicopters, the enemy can employ his. Moreover, enemy helicopters operate in the same airspeed and altitude regimes as ours and carry range-effective weapons similar to U.S. attack helicopters.

The MI-24 HIND presents the most serious threat to friendly helicopters; two versions of the MI-24 are currently being deployed. Both versions are the first Soviet helicopters to be produced that have integral weapons systems. The HIND A is armed with one hundred and twenty-eight 57mm rockets, four AT-2/SWATTER anti-tank guided missiles, and a 12.7mm machine gun in the nose. The HIND A also has a small cargo bay that is used to transport up to eight troops. The HIND D is a streamlined variant of HIND A with the pilot seated

above and behind the copilot gunner. The 12.7mm nose gun has been replaced with a turreted Gatling-type gun; other armament remains unchanged from the HIND A. The latest version, the HIND E is similar to the HIND D except that it has a tube launched AT-6 Spiral Missile System.<sup>25</sup> See Figure 5 Appendix B for more information on the HIND D.

The Warsaw Pact nations have tried to offset or reduce U.S. combat air power effectiveness through the use of extensive and sophisticated mobile air defense mixes of guns, missiles and aircraft which provide overlapping coverage. Soviet doctrine stresses mass concentration of weapons with a formidable employment of complimentary weapons. All Soviet air defense weapons are capable of keeping up with and maintaining air defense coverage for maneuvering forces.

#### SURVIVABILITY ASSESSMENT

The potential real-world threat to attack helicopters is awesome. Although it is hoped that U.S. fixed wing aircraft will have considerably softened enemy air defenses prior to introduction of helicopters to the battlefield, the first-to-fight role of the Marine Corps strongly suggests the probability that any major engagement against hostile Warsaw Pact forces would necessitate flying against the aforementioned defenses.<sup>26</sup> Therefore, the survivability of the attack helicopter options discussed herein must be assessed against this threat. This assessment is discussed in terms of airframe hardening, detectability, weaponry and air-to-air capability.

A. Airframe Hardening. The Army states in its Program Summary of September 1982: "The APACHE is the most survivable helicopter known. This is achieved through a synergistic aggregation of high maneuverability, invulnerability to single impacts of a 12.7mm Armor Piercing Rounds at 1,000 meters Range, and ballistic tolerance to 23mm fire."<sup>27</sup> Some of the design criteria employed to achieve these levels of ballistic tolerance throughout the aircraft's systems include:

- a. Redundancy and separation.
- b. Isolation of sensitive components.
- c. Damage resistant forgings and machined components.
- d. Leakage suppression.
- e. Fire and explosion suppression.
- f. Fire-safe subsystems.
- g. Spallation resistant materials.
- h. Twin engine configuration.
- i. Effective use of armor.

The effective use of armor technique is listed last because the employment of armor, especially parasitic (dead weight) armor, must be a last resort if the aircraft's payload and agility are to be preserved. Ninety-nine percent of the APACHE's parasitic armor is used to protect soft components of the fuel tankage and the helicopter crew. This armor usage assures that not only will the helicopter return from its combat mission because of a redundant crew of pilot and copilot, but that individual crewman have a better chance of surviving enemy action in the APACHE than in any other helicopter existing or planned.<sup>28</sup>

The COBRA also has a twin-engine configuration and isolation of certain sensitive components. It has self-sealing fuel tanks, but only in the lower two-thirds of the tanks and it is only effective against small arms fire. Parasitic armor is used only in the flight crew's seats. In comparison with the APACHE's airframe hardening the COBRA comes up seriously lacking. The lack of armor plating around components, no fuselage hardening, and the absence of flight control system ballistic hardening is a serious deficiency that limits the COBRA's capability to survive in the mid-intensity battle scenario. A cost analysis of armor improvements for the COBRA is discussed in Section 5.

B. Detectability. In this category, the APACHE holds a slight advantage. Its rotor system is advertised as 50% quieter than the COBRA and is supposed to be a "lower flicker" system.<sup>29</sup> The COBRA has a narrower silhouette than the APACHE by 6.5 feet. (See Appendix B, Figures 2 and 4). The width and heights of the two aircraft are relatively equal. However, the slightly narrower width of the COBRA is a plus, especially when engaging in a head-on attack. In the area of ASE, both aircraft are adequately equipped. Both utilize low IR paint and have an active IR jamming capability. Additionally, both aircraft have radar threat warning and countermeasures systems. In fact, the ASE of the two aircraft are enhancing characteristics far superior to all other helicopters produced to date.

C. Weaponry. The weapons that each of the options carry have been discussed at length in previous sections. However, there are a few points that need to be brought out regarding differences between the APACHE and

COBRA. APACHE weaponry is limited to forward firing weapons, but has a great deal of accuracy due to its fire control system. The COBRA carries a much larger array of weapons including droppable weapons (bombs and flares). This capability greatly enhance the COBRA's ability for mission flexibility to employ a diversification of weapons mixtures to meet envisioned combat scenarios. The most serious deficiency in the COBRA is the lack of a fire control system. Ordnance delivery, except for the guided missiles, requires the use of iron sights and "Kentucky windage" to deliver ordnance on target. This means that for guns, rockets and bombs the COBRA does not have a guaranteed first round hit capability. This aspect is especially critical when engaging ground targets that are firing back and in an air-to-air encounter when survival depends on who not only shoots first, but is the most accurate. Further discussion of this deficiency is included in the "Air-To-Air" discussion below. In addition, a cost analysis to install a fire control system in the COBRA is contained in Section 5.

D. Air-To-Air. In the arena of air-to-air capability against either enemy helicopters or fixed wing aircraft, the COBRA is superior to the APACHE. This superiority is contained in the Sidewinder missile system. During the Falkland Island conflict, 24 of the 31 aircraft shot down by British HARRIER jets were killed with Sidewinder missiles. There were 27 launches with only one hang-up.<sup>30</sup> The Sidewinder has proven to be very reliable and a significant advantage in air-to-air engagements. The COBRA, with the Sidewinder, was the first helicopter to break the so-called "fixed wing only air-to-air barrier" and has greatly enhanced the helicopter's

ability to survive. Also, the advent of Sidewinder on the COBRA will lead to increased survivability of assault transport helicopters. In the past, the COBRA could protect the assault transport helicopters from the majority of ground fire, but had little capability against enemy attack helicopters or fixed wing aircraft.<sup>31</sup> Now, with the Sidewinder, the COBRA has gained an edge against these threats and increased not only its own survivability but that of the transport helicopter. When the turret cannon and wing stores gun pods are added to the Sidewinder capability, the COBRA becomes a formidable air-to-air weapon. If the COBRA was configured with gun pods on all stations it could fire up to 3750 rpm of 20mm cannon. This fire power capability could possibly offset the lack of fire control, due to the fact that a whole area of the sky may be literally saturated with 20mm cannon fire.

The turret cannon of both the COBRA and APACHE are mounted on the centerline of the aircraft and have about the same azimuth and depression capabilities (+110° Azimuth, 50° depression). However, the APACHE's cannon is located rearward below the pilot and copilot positions, while the COBRA's turret is located under the nose. Figure 1 shows the turret positions of each airframe. Thus, the COBRA, with its turret mounted further forward, allows a 17° higher elevation of the turret than the APACHE. This increased elevation capability is a plus in a head-on encounter with enemy aircraft. The added elevation capability will reduce the pitch attitude to encounter a threat from above. With less pitch up required to fire the cannon, airspeed can be maintained which often becomes critical in a "dog fight" type air-to-air encounter.<sup>32</sup>

Also, both helicopters may use their anti-armor missiles in an air-to-air encounter. These weapons are extremely accurate, but are limited by slower maneuvering capabilities in comparison to air-to-air missiles. It is envisioned that the anti-armor missile systems would primarily be used against slow-moving aircraft, i.e., other helicopters and aircraft with maximum airspeeds below 250 kts.

APACHE and COBRA Attack Helicopters

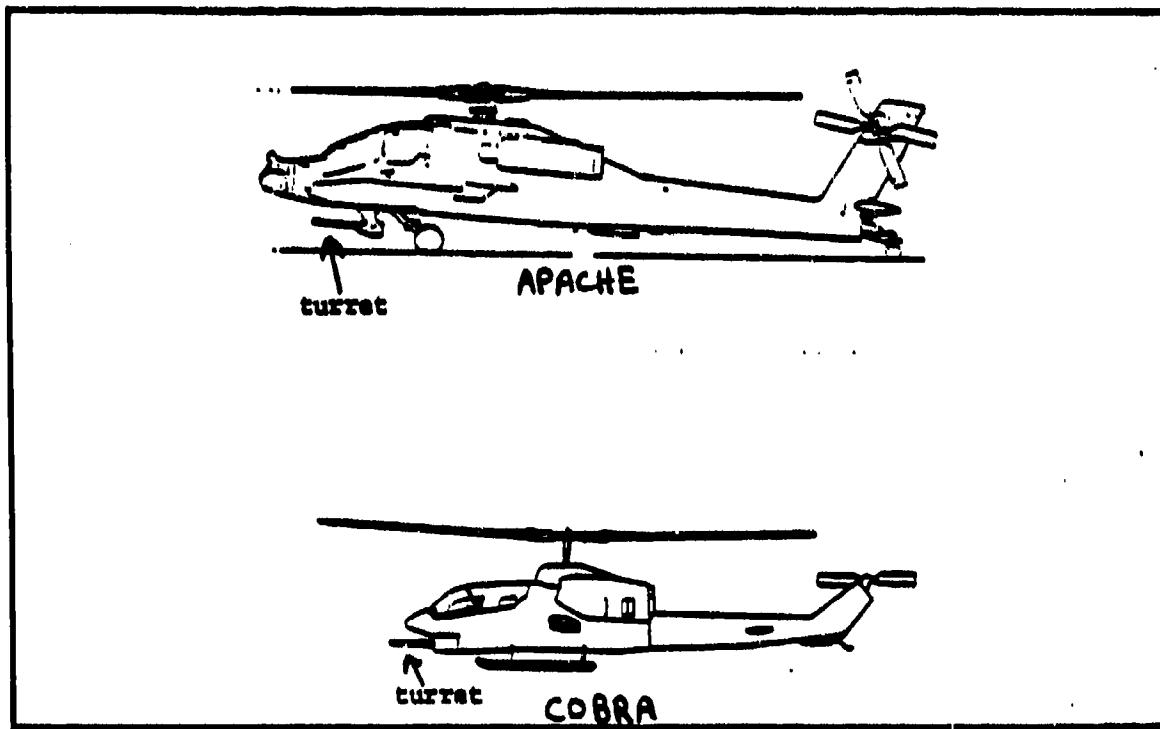


Figure 1

Table 2 summarizes the strengths and weaknesses of the two options in countering the threat as discussed in this section.

TABLE 2  
THREAT COUNTERING SUMMATION

<p><b>Note:</b> (+) and (-) utilized to denote pertinent Strengths/Weaknesses as compared to each other.</p>		
<u>PARAMETER</u>	<u>COBRA</u>	<u>APACHE</u>
Airframe Hardening	<p>(-) Crew Seat Armor Only</p> <p>Lower 2/3 Fuel Tank Self-Sealing</p> <p>Composite Rotor Blades for Ballistic Tolerance</p> <p>Twin Engines</p>	<p>(+) Effective use of Armor</p> <p>(+) Ballistic Tolerance to 23mm Rounds (All Areas)</p> <p>(+) Redundant System</p> <p>(+) Isolation of Components</p> <p>(+) Spallation Resistant Construction Material</p> <p>(+) 12.7mm Invulnerability Twin Engines</p>
Detectability	<p>(+) Narrow Silhouette</p> <p>Engine IR Suppression</p> <p>IR Detection</p> <p>Radar Warning</p>	<p>(+) Quiet Rotor System and Low Flicker</p> <p>(+) Engine IR Suppression</p> <p>(+) Low Reflecting Canopies</p> <p>IR Detection</p> <p>Radar Warning</p>
Weaponry	<p>(-) Fire Control</p> <p>Hellfire</p> <p>20mm Turret Cannon</p> <p>2.75 in. FFAR</p> <p>(+) 5 in. FFAR</p> <p>(+) Bombs</p> <p>(+) Flares</p> <p>(+) Smoke Grenades</p> <p>(+) TOW</p> <p>(+) 20mm Gun Pods</p>	<p>(+) Fire Control</p> <p>Hellfire</p> <p>30mm Turret Cannon</p> <p>2.75 in. FFAR</p> <p>(-) Droppable Wing Stores</p>
Air-To-Air	<p>(+) Sidewinder</p> <p>Hellfire</p> <p>TOW</p> <p>20mm Turret Cannon</p> <p>2.75 in. FFAR</p> <p>(+) 20mm Gun Pods</p> <p>5 in. FFAR</p>	<p>30mm Turret Cannon</p> <p>Hellfire</p> <p>2.75 in. FFAR</p> <p>(-) Air-To-Air Missile System</p>

SUMMARY

Considering the pluses and minuses of both aircraft, it is apparent the each have very impressive capabilities to counter the threat. The APACHE has used advanced technology in the areas of airframe hardening and detectability to aid in defeating the threat. The COBRA is somewhat less sophisticated in its five control systems and airframe technology, but has a much greater array of weaponry to counter the known threat and may have an advantage in weapons flexibility over the APACHE. The air-to-air capability of the COBRA must be considered the most significant advantage over the APACHE.

## SECTION V

COST ANALYSIS

Funds have been budgeted in FY84 through FY88 for procurement of 44 COBRA attack helicopters. FY84 funds are for long lead items. The FY85 and 86 monies are for aircraft procurement and the FY87 and 88 funds are for earmarked for ground support equipment and other support costs. Table 3 depicts the budgeted procurement program.

AH-1T COBRA PROCUREMENT PROGRAM<sup>33</sup>

(\$ In Millions)

<u>ITEM</u>	<u>FY84</u>	<u>FY85</u>	<u>FY85</u>	<u>FY86</u>	<u>FY88</u>
Total Dollars	\$17.8	\$159.8	\$180.8	\$11.6	\$ 3.7
Aircraft Quantity		22	22		
Aircraft Delivery			22	22	
<b>Total Procurement \$ = 373.7</b>					

TABLE 3

Planned cost will be evaluated in terms of total cost per aircraft and how many of each type the budgeted amount will procure as the aircraft are presently configured. Additionally, cost estimates will be presented for improvements or changes that are desired as discussed in previous sections. There are other areas of aircraft procurement that effect the total cost, but are budgeted through different procurement systems and are considered outside

the scope of this study, e.g., personnel requirements, training and training equipment changes. However, the general impact on these areas will be discussed.

The 1983 budget submission requested the procurement of 44 COBRAs for replacement of attrited attack helicopters. The budget submitted requires delivery of aircraft in 1986 and 1987 at 22 aircraft per year. There is also an FY85 Program Objective Memorandum (POM) submitted for additional attack helicopters to meet an increased force level buildup of 88 attack helicopters. This funding issue profile is shown by Table 4.

AH-1T COBRA FY85 POM ISSUE<sup>34</sup>

(\$ In Millions)

<u>ITEM</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>	<u>FY89</u>	<u>FY90</u>
Total Dollars	\$10	\$156	\$240	\$246	\$252	
Aircraft Quantity		16	24	24	24	
Aircraft Delivery			16	24	24	24
Total Procurement \$ = 904						

TABLE 4

Viewing both the approved funding profile and the proposed profile and assuming that they are both approved, the total dollars for the attack helicopter procurement for the Marine Corps through 1990 is shown by Table 5.

ATTACK HELICOPTER PROCUREMENT PROFILE<sup>34</sup>

(\$ In Millions)

<u>ITEM</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>	<u>FY89</u>	<u>FY90</u>
Budgeted Dollars	\$17.8	\$159.8	\$180.0	\$11.6	\$3.7		
Requested Dollars		\$ 16.0	\$156.0	\$240.0	\$246.0	\$252.0	
Aircraft Quantity		22	38	24	24	24	
Aircraft Delivery			22	38	24	24	24
Total Procurement \$ = 1283.7							
Total Aircraft		132					

TABLE 5

The key element in Tables 3 through 5 is that all funds are aircraft procurement dollars with no Research and Development (R&D) funds. Therefore, any procurement of attack helicopters that would require R&D funds will require a funding issue with the first requirement submitted in POM 85. Another way to obtain R&D funds prior to FY85 is a possible reprogramming in the FY83 and 84 budget. However, the Marine Corps historically has not been prone to reprogramming R&D funds other than in small amounts for existing programs. This fact is especially significant since the procurement of COBRAs does not require R&D funds, while procurement of the APACHE will require R&D funds for shipboard compatibility modifications.

To establish a baseline for the procurement costs of both aircraft it is necessary to outline the aircraft costs as they are presently budgeted without any improvements in the COBRA or shipboard compatibility of the APACHE. Table 6 outlines the basic cost estimates.

ESTIMATED PROCUREMENT COST<sup>35</sup>

(\$ In Millions)

	<u>COBRA</u>	<u>APACHE</u>
Unit Flyaway	\$ 8.1	\$ 13.9
Unit Procurement	9.1	17.0
Unit Investment	10.6	20.0

TABLE 6

With the baseline cost established, it is now necessary to expand the cost analysis to shipboard compatibility for the APACHE and airframe improvements in the COBRA. Table 7 is a breakdown of the major areas of improvement for both helicopters and estimated costs for those changes.

ATTACK HELICOPTER R&D COSTS

(\$ In Millions)

<u>ITEM</u>	<u>COBRA</u>	<u>APACHE</u>
Airframe Improvements	Armor Plating Ballistic Tolerance	None None
System Improvements	Fire Control System Improved Night Vision VHF Radio	AIM-9L Missile Droppable Stores
Shipboard Compatibility	Improved IR Paint	Main Rotor Fold Main Rotor Brake USMC avionics Wheel Brakes Airframe Tie Downs HERO Corrosion Prevention
Estimated Cost	\$ 18 - 25	\$ 160 - 210

TABLE 7

The R&D costs of Table 7 do not include the recurring cost for acquisition of the improvements. A study of those costs is being conducted by the Marine Corps and will be completed in late 1983. Therefore, only R&D costs will be added to the unit procurement cost of each aircraft so as to compare like entities.

WHAT THE DOLLARS WILL BUY

Based on the current appropriations and projected funding request issues shown above, it is necessary to examine what procurements could be accomplished in present attack helicopter configurations and with improvements:

A. Basic COBRA	- \$1284m	\$10.6m = Approx. 121 aircraft
B. Basic APACHE	- \$1284m	\$20.0m = Approx. 64 aircraft
C. Improved COBRA	- \$1284m	\$10.8m = Approx. 119 aircraft
D. Improved APACHE	- \$1284m	\$21.5m = Approx. 60 aircraft

Examining the figures above shows that approximately twice as many COBRAS can be procured as APACHES. However, even without recurring costs for improvements added in, the required 132 airframes cannot be procured. Therefore, in all of the alternatives an increase in funding will have to be accomplished to meet the U.S. Marine Corp's desired end aircraft inventories. The somewhat unpalatable alternative is to stay within the budget and reduce the number of attack helicopters. The key element in any of the options is that the APACHE is twice as expensive as the COBRA. Therefore, the question is, are the capabilities of the APACHE equal to or more desirable than those of two COBRAS? From this study of the two helicopters, the answer is considered to be NO. The APACHE does have excellent survivability, state-of-the-art fire control systems and airframe technology and excellent night vision capability, but it is not twice as capable as the COBRA. Accordingly, in terms of both initial procurement and additional cost factors, the COBRA represents the most cost effective alternative for the Marine Corps. Another key factor is that the COBRA is presently in service in the Marine Corps. If the APACHE were chosen, some additional costs that have not been addressed will be encountered. These include:

- A. Retraining aircrews
- B. Retraining maintenance and support personnel
- C. Initial stockage and supply chain establishment
- D. Procurement of special tools, test and support equipment
- E. Publishing new manuals to support a new aircraft

SUMMARY

The terms of initial procurement and additional cost factors, the COBRA represents the cheapest alternative with adequate capability to successfully accomplish the mission. The APACHE does have more advanced systems and greater survivability, but it is almost twice as expensive as the COBRA in either comparison. The most serious short fall of the APACHE is its lack of shipboard compatibility and the 200 million dollar R&D price tag to alleviate this deficiency.

## SECTION VI

### CONCLUSIONS AND RECOMMENDATIONS

Both of the attack helicopter procurement options considered can accomplish the Marine Corps mission. Each has enhancing characteristics that offset their deficiencies. However, the deciding factor is the ever important cost effectiveness aspect of any procurement. As can be ascertained from this comparative study, the decision as to which option to procure is neither easy nor clear cut from examination of airframe capabilities. But when the cost is interjected, the picture becomes clearer. With the APACHE almost twice as expensive as the COBRA, the question is are two COBRAs as effective as one APACHE. Examining some of the helicopters' characteristics may help in this determination.

#### AH-1T COBRA

##### ENHANCING CHARACTERISTICS

- A. Already in service
- B. Proven capability
- C. Shipboard compatible
- D. Air-To-Air missile system
- E. Droppable wing stores
- F. More versatile turret
- G. Wing stores gun pods
- H. Narrow silhouette

##### DEFICIENCIES

- A. Lack of airframe ballistic tolerance
- B. Lack of fire control system
- C. Inadequate IR paint

AH-64 APACHE

ENHANCING CHARACTERISTICS

- A. Effective use of armor
- B. Airframe ballistic tolerance
- C. Airframe hardening
- D. Fire control system
- E. Low reflective canopies
- F. Low flicker rotor system
- G. Redundant flight controls
- H. VHF radio communications

DEFICIENCIES

- A. Approximately twice the cost of the COBRA
- B. No Air-To-Air missile system
- C. Not shipboard compatible
- D. No droppable wing stores
- E. New aircraft - not yet in the field

Currently the Marine Corps' has three active attack helicopter squadrons.

Two of these squadrons are operating the AH-1T COBRA and the third is utilizing the older AH-1J SEA COBRA. The FY85/86 procurement of COBRAs is intended to replace attrited aircraft and the squadron of AH-1J COBRAs. In order to accomplish these goals, the planned helicopter procurement is a minimum requirement based on projected attrition and deployment commitments. There are barely enough budgeted funds to accomplish the presently proposed procurement of the COBRA as currently configured. Additionally, introduction

of a new model helicopter would severely hamper maintenance and supply support over the life cycle of the aircraft and cause undue turbulence in a comparatively small community of aircraft.

While the APACHE offers some very attractive improvements over the COBRA, it is not felt that, at almost twice the cost of a COBRA, the APACHE is the most cost effective alternative for the Marine Corps.

#### RECOMMENDATIONS

It is recommended, based on the information presented and from the "user" point of view, that the U.S. Marine Corps should contract with Bell Helicopter Textron, Inc. for as many additional AH-1T COBRA attack helicopters as the available funding will allow. It is further recommended that the Marine Corps commence an indepth evaluation of the modifications required to make the APACHE shipboard compatible and determine the exact recurring and non-recurring costs of such a program for possible implementation as a follow-on to the AH-1T COBRA.

FOOTNOTES

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<sup>2</sup>LT COL H. P. L. Miller (USMC), "Attack Helicopter in the Mid Intensity Environment," DCS for Aviation Staff Study HQMC, 1972.

<sup>3</sup>Interview with Mr. Robert Johnston, Consultant to Naval Air Systems Command, PMA 276 Program Manager for H-1 aircraft: December 1982.

<sup>4</sup>Interview with Major Randy West (USMC), Action Officer DCS for Aviation HQMC: September 1982.

<sup>5</sup>Major General Edward M. Browne (USA), "U.S. Army Advanced Attack Helicopter Program Summary," U.S. Army Development and Aviation Research Command, September 1982.

<sup>6</sup>Telephone conversation with LT COL B. R. Leudtke (USMC), Naval Air Systems Command, Engineering Project Officer for Attack Helicopters : September 1982.

<sup>7</sup>U.S. Navy, Naval Air Systems Command, Natops Flight Manual AH-1T Aircraft, CNO Washington, D.C., July 1978, p. 8-1.

<sup>8</sup>U.S. Army, Advanced Attack Helicopter and Mission Equipment Package: Federal Republic of Germany, p. 2-2, 2-21.

<sup>9</sup>Bell Helicopter Textron, "U.S. Marine Corps AH-1T: Multi-Mission Attack Helicopter," May 1982, p. 4.

<sup>10</sup>Raytheon Company, "Sidewinder AIM-9L: Weapon System," July 1981, p. 4-7.

<sup>11</sup>"U.S. Marine Corps AH-1T: Multi-Mission Attack Helicopter," p. 3.

<sup>12</sup>"U.S. Army Advanced Attack Helicopter - Program Summary," p. 1-5.

<sup>13</sup>Advanced Attack Helicopter and Mission Equipment Package, p. 2-52.

14 *Ibid.*, p. 2-53, 2-54.

15 *Hughes Helicopter, Inc., "AH-64 APACHE For The U.S. Marine Corps,"* October 1982, p. 2-3.

16 *Department of the Navy, United States Marine Corps, FMFM 5-1 Marine Aviation, Commandant of the Marine Corps, Washington, D.C., August 1979*, p. 39.

17 *Ibid.*, p. 40.

18 *Hughes Aircraft Company, "Airborne TOW Missile System: Choice of Military Around The World,"* June 1981, p. 2.

19 *Ibid.*, p. 3.

20 *"Advanced Attack Helicopter and Mission Equipment Package,"* p. I-34, I-35.

21 *Ibid.*, p. I-5

22 *James H. Merryman, "Bring Army Aviation Through The 70's and 80's," USA Aviation Digest, June 1974.*

23 *Headquarters Department of the Army, Operations, FM 100-5, July 1979.*

24 *Casper W. Weinberger, Preface to, Soviet Military Power, Department of Defense, p. 2.*

25 *Ibid.*, p. 34-35.

26 *FMFM 5-1, Marine Aviation, p. 125.*

27 *"Advanced Attack Helicopter and Mission Equipment Package,"* p. 2-53, 2-54.

28 *"U.S. Army Advanced Attack Helicopter Program Summary,"* p. 2.

29 *Ibid.*, p. 4.

30Anthony H. Gordesman, "The Falkland Crisis: Emerging Lessons for Power Projections and Force Planning," Armed Forces Journal, September 1982, p. 32.

31pilot interviews and personal experience.

32NAVAL AIR SYSTEMS COMMAND, "P-1 Program Budget Worksheet, 1983 Budget Update," December 29, 1982.

33Headquarters Marine Corps, "Briefing For The Commandant," December 1982.

34Ibid.

35Cost Analysis discussion between Major Randel West (USMC), APW-53 HQMC, Mr. Robert Johnston, consultant to Naval Air Systems Command and LT COL B. R. Leudtke (USMC), February 8, 1983.

36Hughes Helicopter, Inc., "AH-64 Cost Study for the Marine Corps Mission," June 10, 1982.

FIGURE 1  
AH-1T COBRA

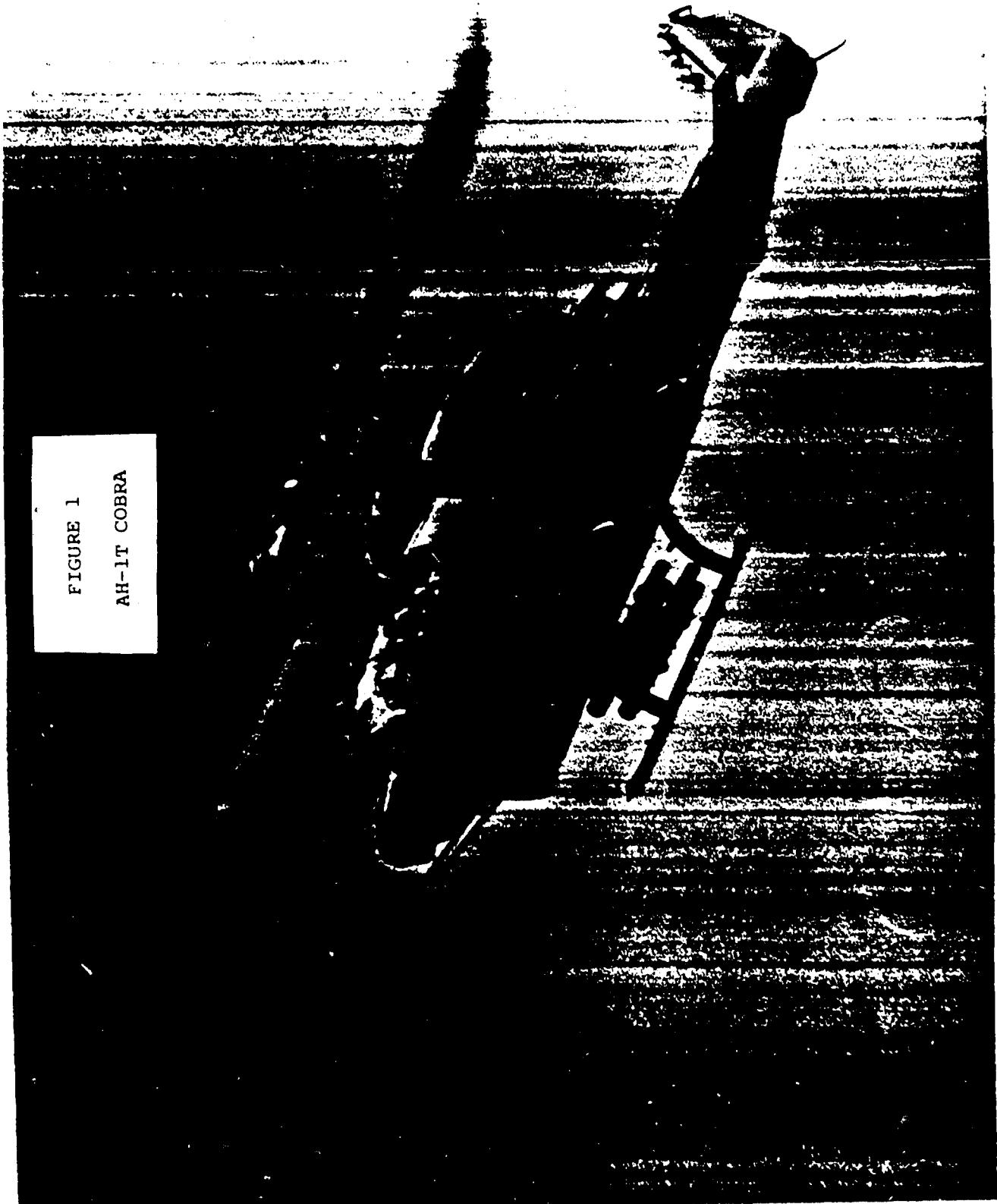


FIGURE 2  
AH-1T COBRA DIMENSIONS

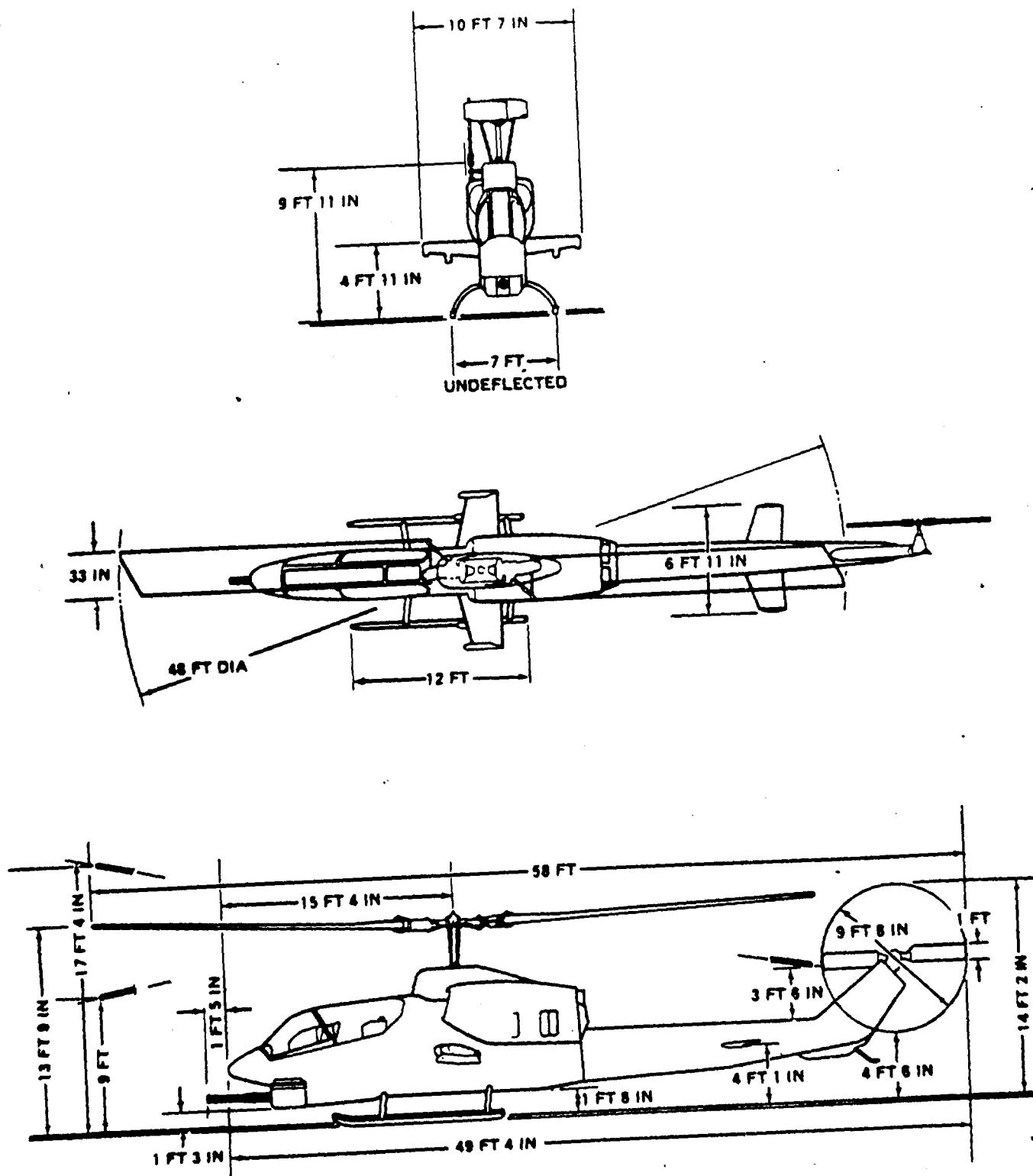


FIGURE 3

AH-64 APACHE

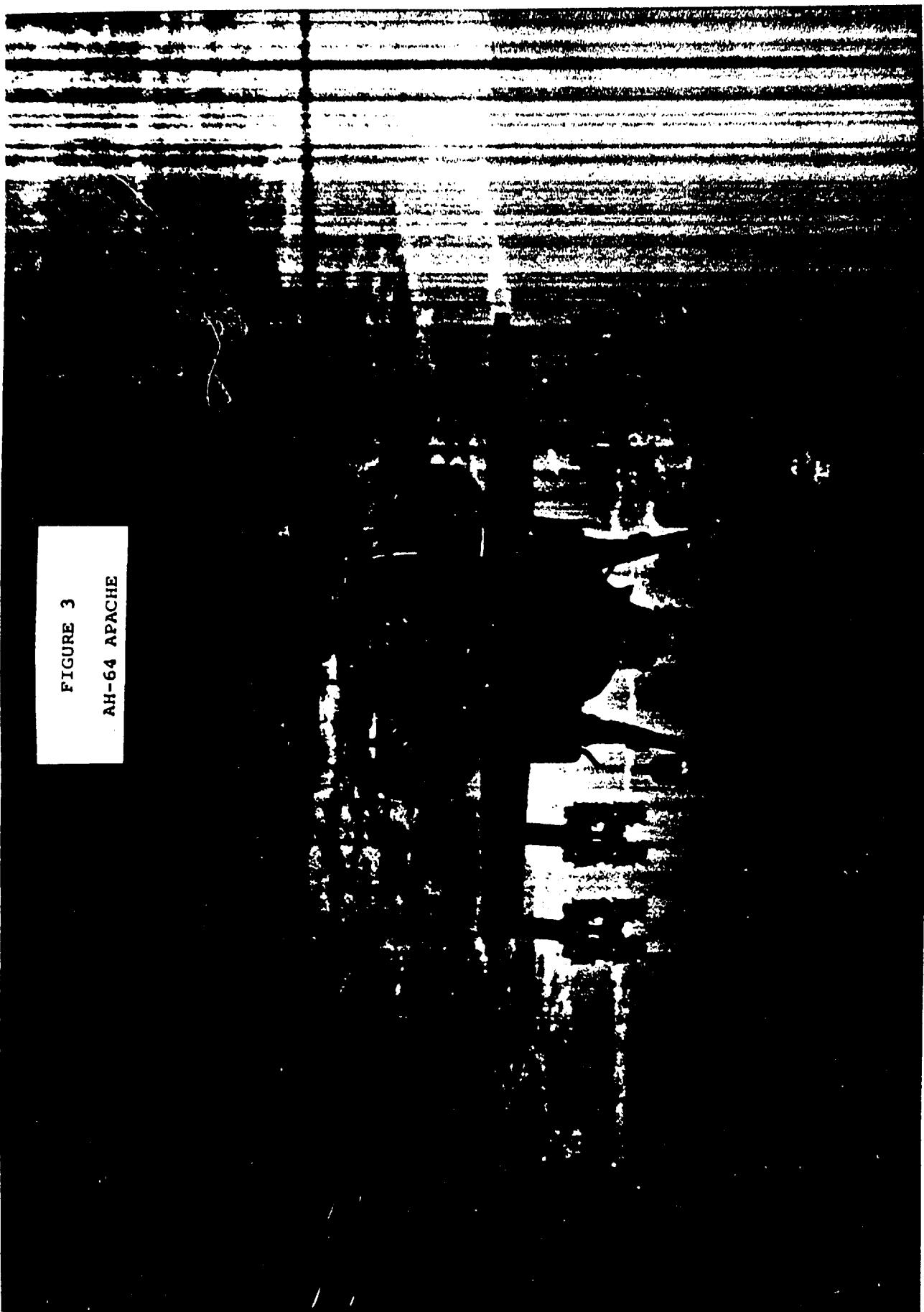


FIGURE 4

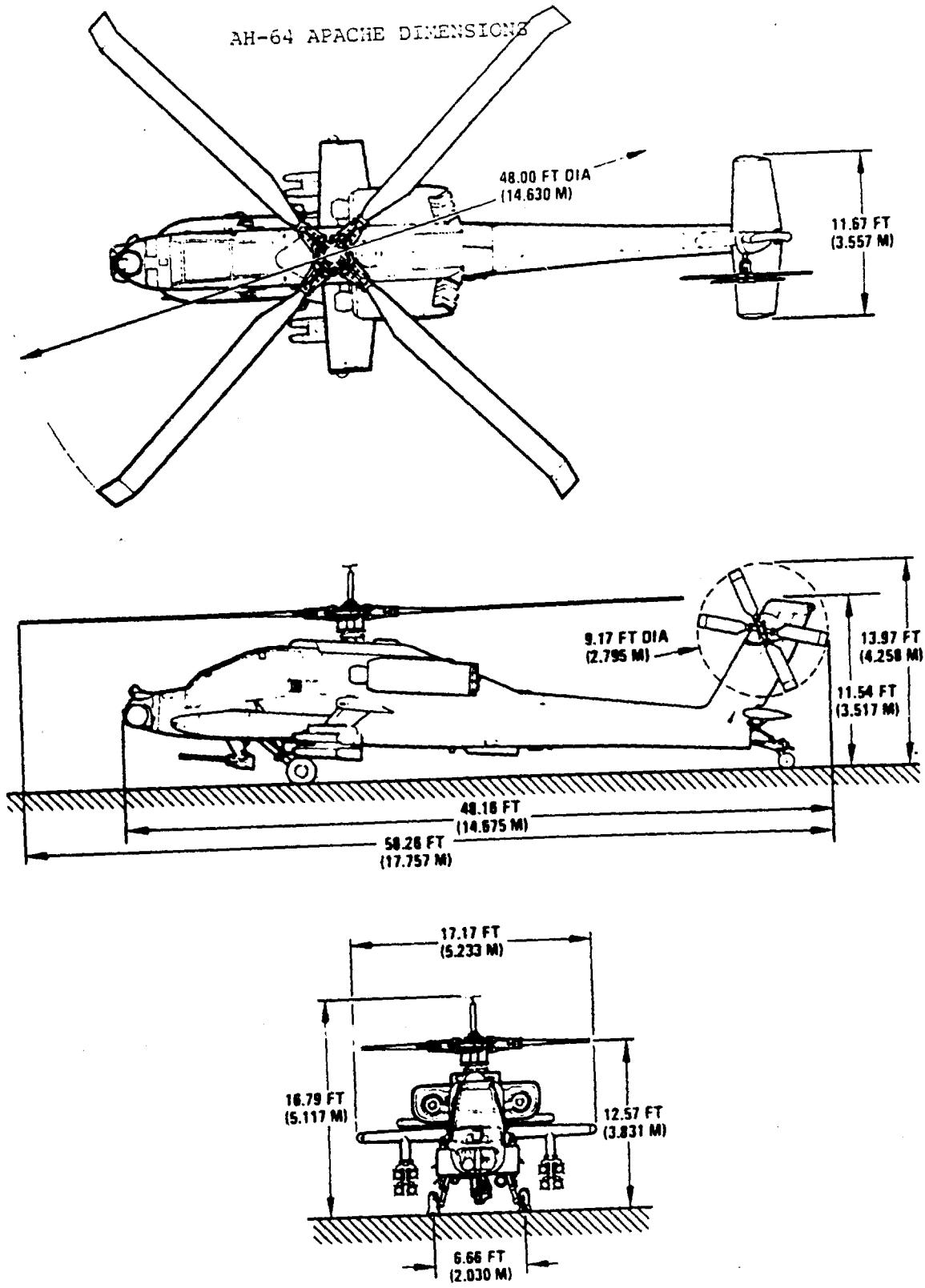
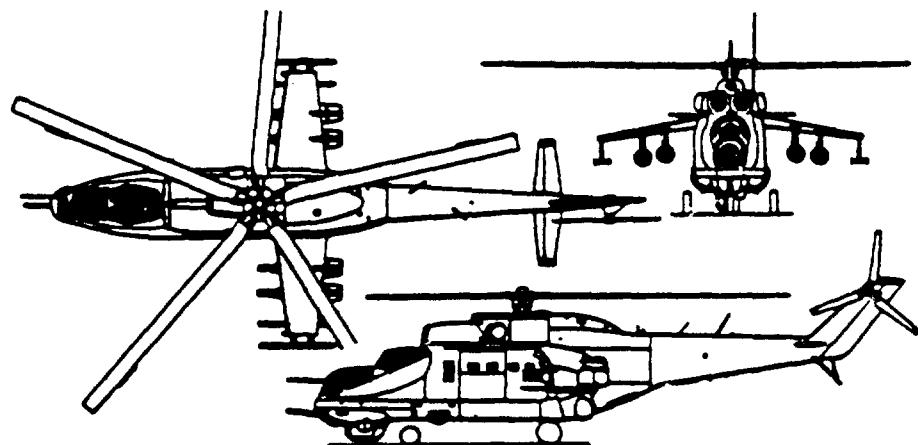


FIGURE 5



**MI-24 HIND-D GUNSHIP**

Basically similar to late-model 'Hind-A', with tail rotor on port side, but with front fuselage completely redesigned for primary gunship role. Tandem stations for weapon operator (in nose) and pilot have individual canopies. Front canopy hinged to open sideways, to starboard; footstep under starboard side of fuselage for access to pilot's rearward-hinged door. Rear seat raised to give pilot an unobstructed forward view. Probe fitted forward of top starboard corner of bulletproof windscreen at extreme nose may be similar to US low-airspeed sensing equipment, to indicate optimum conditions for minimum dispersion of 57mm rockets. Under nose is a four-barrel Gatling-type large-calibre machine-gun in a turret with a wide range of movement in azimuth and elevation, providing air-to-air as well as air-to-surface capability. Under-nose pack for sensors, possibly including radar and low-light-level TV. Wing armament of 'Hind-A' retained, but forward-looking (electro-optical) sensor transferred from top of port inner pylon to wingtip. Many small antenna and blisters. Extended nosewheel leg to increase ground clearance of sensor pack; nosewheels semi-exposed when retracted.



DEPARTMENT OF THE NAVY  
NAVAL AIR SYSTEMS COMMAND  
NAVAL AIR SYSTEMS COMMAND HEADQUARTERS  
WASHINGTON, DC 20361

IN REPLY REFER TO

AIR-5511H/HHP  
Ser 47

MEMORANDUM

SEP 29 1981

From: AIR-5511H  
To: AIR-5115E  
Via: AIR-551

Subj: Trip Report, Assessment of the YAH-64 Helicopter for  
Marine Corps Mission

Ref: (a) MEMO AIR-5115E/BRL of 19 Aug 81  
(b) AIRTASK A512-512C/051-F/1W0599-0000, WUA A5115E1-01  
(c) SD-24K Vol, II "General Specification for  
the Design and Construction of Aircraft Weapon  
Systems Rotary Wing Aircraft"  
(d) MIL-T-81259

1. In response to reference (a), the undersigned participated in the subject assessment as a member of a team of engineers from NAVAIR and Navy field activities. The assessment consisted of briefings and discussions with Hughes Helicopters engineers at Culver City, CA, 9-11 September, and a "hands on" look at the development aircraft at Yuma Proving Grounds, AZ, 14-16 September. The undersigned was chairman of the shipboard compatibility committee, his assigned area of responsibility, and was assisted by Don Brown of the Naval Air Engineering Center under reference (b). The Hughes committee member was Mr. Peter Cross.

2. Background. The AH-64 Advanced Attack Helicopter was developed by Hughes for the U.S. Army. It is scheduled to undergo DSARC III in December 1981. The U.S. Marine Corps wants to acquire the AH-64, suitably modified for deployment aboard the LHA, LPH, and LPD type ships. The purpose of the subject assessment was to become familiar with the YAH-64, and to determine those modifications necessary for the Marine Corps mission. Since the helicopter was designed to Army requirements, there are a number of areas which require change for satisfactory shipboard operations. These details follow.

3. Rotor System

A. Blade Fold. The present main rotor is designed for manual folding to accommodate transportation on cargo airplanes. According to Hughes, this requires 4 to 5 men and 30 minutes. The system is designed for wind "gusts" to 45 knots. Obviously, this is unacceptable for shipboard operations, both from a time and manpower standpoint, and because the hub/blade joints were designed for occasional vice repeated folding. The ideal system would fold all blades by power in 60-90 seconds.

This, however, would require extensive redesign and testing of the hub/blade system, and therefore would be the most expensive option.

Several other schemes were discussed, including orienting the blades at 90 degrees (the Army practice is to orient the blades at 45 degrees to minimize helicopter width with blades spread), and folding the two side blades. The effect of this arrangement on elevator spotting will be discussed separately. In a "brainstorming" session, one Hughes suggestion was to provide a "portable" actuator which could be fitted to each side blade when folding/spreading was desired. This would minimize hub redesign, reduce man power required to two (one at the actuator and one to "walk" the tip around), and still retain positive control of the blades during high winds/ship motion. A thorough study is required from Hughes for several options from full power to manual, showing advantages/disadvantages, tradeoffs, costs, etc.

B. Rotor Brake. The present brake is designed to stop the rotor from 50% RPM in 30-45 seconds, and requires engine shut down prior to application. As such, it does not meet the requirements of paragraph 3.12.15.4 of reference (c) which calls for stopping the rotor from 100% RPM in 15 seconds. Inability to meet reference (c) will add considerable time to blade folding after landing aboard ship.

#### 4. Deck Handling.

A. Turnover Angle. Paragraph 3.8.2 of SD-24K Vol. I (Fixed Wing Aircraft) requires a turnover angle of not more than 63 degrees for landbased aircraft and 54 degrees for ship-based aircraft. There is no equivalent requirement in reference (c) (the reason for this omission is unknown). According to Hughes, the turnover angle for the AH-64 is 63 degrees at max gross weight. This will increase at lower gross weights since the absence of stores/fuel will cause the C.G. height above the deck to increase. It is urged that a study be conducted to determine the probability for turnover due to the combined effects of ship motion, wind over the deck, landing gear geometry and dynamics, and sharp turns at excessive speed while taxiing or towing. As a matter of interest, the undersigned was able to induce significant side-to-side rocking in the AH-64 simply by alternately pushing up and pulling down on the wing tip. In another informal branstorming session with Hughes, the possibility of adding outriggers to prevent turnover, similar to those of the AV-8, was suggested. These would not necessarily have to be a permanent part of the aircraft, but could be attached on the deck.

B. Tie-Down. The tie-down provisions do not meet the shipboard requirements specified in reference (d). For example, the area of the opening of the aft tie-down ring, which has been combined with the aft jack point in the Phase II aircraft, is not large enough. Additionally, it is doubted that the existing tie-

down points have sufficient strength to reach the combined inertia loads due to ship motion and wind forces.

Further, the existing tie-down points are not readily accessible. The aft point is under the fuselage, about 18 inches above the ground. There are two tie-down points inboard of the main gear axles; access to these is made difficult by the location of the stores pylons and attached weapons. Also, there are two tie-down points located at the upper end of the main gear lever arms which are reached through doors. This lack of accessibility of design tie-down points will encourage the use of several convenient external maintenance steps as tie-down points. These steps have not been stressed for securing loads.

C. Towing. The AH-64 is currently towed/pushed from the tail wheel by an 11 foot tow bar and conventional tractor. It appears that both the SD-1 spotting dolly and ML handler will be compatible. The main gear axle tie-down points also double as towing rings. Visual inspection suggests that the standard 15 foot Navy tow bar will fit with sufficient clearance both between the tow bar and the gun, and between a tractor and the nose of the helicopter. However, both dimensional and physical checks should be made to confirm this.

D. Spotting. There was concern that the AH-64 would not fit on the elevators of LHA and LPH class ships without relocating the tail wheel. In order to resolve this, the undersigned constructed templates of the helicopter in two configurations, one with all blades folded and one with the rotor oriented at 90 degrees with the two side blades folded, and also made a layout of the after hangar deck of the LHA at the same scale. Studies showed the following:

(1) All blades folded;

(a) With the tail outboard, the AH-64 fits with difficulty on the 34 ft. X 50 ft. deck edge elevator common to the LHA and LPH. Spotting alignment will have to be precise and will require man-handling due to lack of room for tow bars/tractors (except on the flight deck level). Spotting-on or removal at the hangar deck level must be done by hand and is exceedingly tight. Overall, this is not practical.

(b) With the tail outboard, the AH-64 fits fairly easily on the 35 ft. X 60 ft. aft elevator of the LHA, and the ML handler can remain attached to the tail wheel if the helicopter is spotted somewhat on the diagonal. Removal at hangar deck should be no problem.

(c) With the nose outboard, the AH-64 fits easily on both elevators at either flight or hangar deck level, and the ML handler can remain attached at all times. The AH-64 must be spotted diagonally on the deck edge elevator, and can be spotted straight-on the aft elevator.

(2) Two blades folded:

(a) With the tail outboard, the AH-64 will not fit on the deck edge elevators, and will only fit diagonally on the aft elevator. In the latter case, man-handling will be required to complete the spot due to lack of room.

(b) With the nose outboard, there is no problem with spotting the AH-64 on either the deck edge or aft elevators, and the ML handler can remain attached. Spotting on the more critical deck edge elevator was demonstrated at the Yuma Proving Grounds. An inexperienced tractor driver, pushing from the tail wheel, needed only two attempts to correctly locate the aircraft on a simulated elevator with more than five feet of clearance all around. In conclusion, relocation of the tail wheel is not necessary.

5. Servicing. A report on shipboard servicing and facilities requirements is being prepared by the Naval Air Engineering Center and will be forwarded when available.

6. Corrosion. The top of the aft fuselage, under the tail rotor drive shaft fairing, is open. In the opinion of the undersigned, this will permit entrance of salt spray and other corrosive agents aboard ship, and will encourage accelerated corrosion. On two vehicles inspected at YPG, this area contained noticeable amounts of dirt, plant materials, etc.

7. Required Changes. Based on available information, the undersigned submitted the following chits as mandatory or desirable for shipboard operations:

A. Rotor Fold: Discussed in paragraph 3.A above.

B. Fuel Point: Relocate fueling point to permit gravity refueling without engine shutdown.

C. Turnover Angle: Discussed in paragraph 4.A above; should be in accordance with paragraph 3.8.2 of SD-24K Vol. I.

D. Tie-Down: Discussed in paragraph 4.B above; should be in accordance with reference (d).

E. External Steps: Discussed in paragraph 4.B above; these should be replaced by flush steps to prevent misuse as tie-down points.

F. Corrosion Prevention: Ensure all pockets on magnesium gear boxes have drain holes in accordance with paragraph 3.2.4.1.2.3 of reference (c).

G. Fretting Corrosion: Ensure all contact areas between maintenance doors and aircraft structure are protected by

suitable insulating material in accordance with paragraph 3.2.4.2.4 of reference (c).

H. Maintenance Doors Ensure maintenance doors are held open by self locking devices in accordance with paragraph 3.2.4.2.4 of reference (c).

I. Fuel Point Access Panel: Ensure access panel covering the pressure fuel point is hinged to the fuselage structure in accordance with paragraph 3.2.4.2.4 of reference (c). The present panel is not hinged and is retained when loose only by a cable. This cable was broken on YAH-64 ship AV02 which would have resulted in probable loss of the panel aboard ship and possible engine FOD.

8. Information Request: The following additional information is required in order to more fully assess the AH-64 for shipboard operations, and has been informally requested of Hughes Helicopters:

A. Height:

(1) To remove main rotor and other critical items including necessary hoisting sling, etc. The hangar height of the LHA and LPH is 20 feet, with a limited 23 foot "high hat" area on the LHA.

(2) When jacked to change main wheel or replace main landing gear.

B. Carrier Deck Strength Data: In accordance with paragraph 3.5.18 of MIL-D-8706 and DID (Data Item Description) DI-S-21542A.

C. APU: Exhaust temperature, velocity and noise profiles.

D. External Stores Drawings: Showing ground lines and deck clearances with aircraft in static attitude and with one main gear compressed and tire flat.

E. Engine Removal: Description and drawings of engine removal with main rotor blades folded.

F. Servicing:

(1) List of fluids (oil, grease, etc.) and gasses including quantities, types, MIL SPEC numbers, and aircraft components requiring same.

(2) Compatibility of external power receptacles, refueling points and cooling/pressure/hydraulic fittings with shipboard equipment.

G. Ammunition Loading: Details of the ammunition up-

loading/down-loading equipment and procedures if the Hughes 30 mm chain gun is retained for the Marine Corps mission.

9. Photographs: A series of photographs depicting tie-down accessibility/misuse, maintenance doors, etc. was taken with the cooperation of Hughes. A set of these photographs will be forwarded when received.

10. General Conclusions: All Hughes Helicopter personnel encountered during the subject assessment were most helpful and cooperative. However, it is apparent that they lack background and experience in Navy requirements and shipboard operations. The AH-64, as presently designed to Army needs, can be successfully adapted for shipboard operations.

Respectfully,

*Huntley H. Perry*  
Huntley H. Perry

Copy to:  
PMA-261  
AIR-5303  
AIR-5163  
NAEC-9112

*[Handwritten arrow pointing to PMA-261]*

## GLOSSARY

### Abbreviations and Acronyms

AIM-9L MODEL L Sidewinder Missile

ASE Airborne Survivability Equipment

FACA Forward Air Control Airborne

FFAR Folding Fin Aerial Rockets

FLIR Forward Looking Infra-Red Radar

FOV Field of View

FYDP Five Year Defense Plan

HELLFIRE LASER Guided Anti-Armor Missile

HERO Hazard of Electromagnetic Radiation to Ordnance

IR INFRA-RED

kts Knots of airspeed

LPD Landing Platform Dock (Amphibious Ship)

LPH Landing Platform Helicopter (Helicopter Aircraft Carrier)

LZ Landing Zone

m millions

mm millimeter

POM Program Objective Memorandum

PNVS Pilot Night Vision Sensor

R&D Research and Development

RPM Rounds per minute

SIDEWINDER AIM-9L heat seeking missile

USMC United States Marine Corps

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